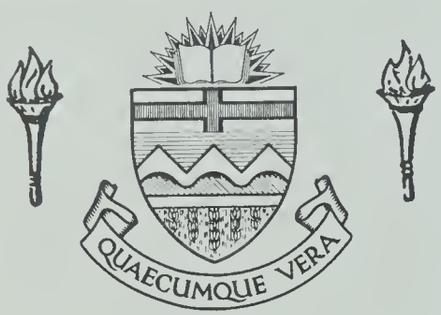

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LINDER'S THEORY
AND 1965 JAPANESE EXPORTS

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled LINDER'S THEORY AND 1965 JAPANESE EXPORTS submitted by Nobuo Fujita in partial fulfilment of the requirements for the degree of Master of Arts.

ABSTRACT

This thesis examines Japanese exports to the major developed nations of the world in the light of current theories about the determinants of international trade. Particular attention is given to testing S. Burenstem Linder's hypothesis that the volume of trade in manufactures of a country with her trading partners will be greater, the greater the similarity in demand patterns of the pair of trading nations. This hypothesis is refined and then tested using Japanese export data for 1965.

It is concluded that the Linder hypothesis is not a satisfactory explanation of recent Japanese export to developed nations of the western world. Alternative explanations of Japan's trade are briefly considered. Finally, possibilities for further empirical investigation are suggested.

ACKNOWLEDGEMENTS

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INTRODUCTION

The ultimate purpose of my thesis is to test the hypothesis developed by a Swedish economist, S.B. Linder[1]. Linder assumes unidentical tastes between countries on the basis of the non-homothetic characteristic of the individual's indifference map and the different per capita income levels among countries. He postulates that greater the per capita income difference, the smaller the intensity of trade of manufactured products between countries.

My results reject Linder's hypothesis and show that per capita income difference is important in the opposite way to what was suggested by Linder, i.e., the greater the per capita income difference, the greater the intensity of trade. My main conclusion from this study is that Linder's hypothesis does not apply to the Japanese export trade of manufactured products with developed countries of the world.

Chapter I summarizes critical re-examinations of the contemporary Heckscher-Ohlin model of international trade in the recent literature, and discusses Linder's explanation as one of the new theories developed under this general trend in criticism. Chapter II examines the theoretical framework of

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[1] S. Burenstam Linder, An Essay on Trade and Transformation (New York: Wiley and Sons, 1961).

Linder's model in detail, reformulates the model into such a form so that it can be empirically tested. Chapter III reviews the econometric models of Tinbergen,[1] Pöyhönen[2] and Linnemann,[3] and presents my models. Chapter IV summarizes their contributions and gives my results and interprets them. Chapter V gives the concluding remarks of the present study.

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[1] Jan Tinbergen, Shaping the World Economy: Suggestions for an International Economic Policy (New York: The Twentieth Century Fund, 1962), see Appendix VI, pp. 262-293.

[2] Pentti Pöyhönen, "A Tentative Model for the Volume of Trade Between Countries", Weltwirtschaftliches Archiv, Band XC (1963), pp. 93-99.

[3] Hans Linnemann, An Econometric Study of International Trade Flows (Amsterdam: North Holland, 1966).

CHAPTER I

THE CONTEMPORARY HECKSCHER-OHLIN MODEL AND NEW THEORIES OF TRADE

The contemporary Heckscher-Ohlin model[1] (not to be identified with Ohlin's[2] original model) emphasizes international differences in relative factor endowments of capital and labour as the primary explanation of international trade. It tends to ignore natural resources as a factor of production. It assumes the identity of factor qualities and production functions among countries, and irreversibility of factor intensities. It ignores the economies of scale by assuming constant returns to scale in production. The model further assumes that countries' tastes are not too skewed.

Both the assumptions and the empirical implications of the model have been subjected to much criticism in the literature. A number of new explanations of the pattern of international trade have been developed in the 1960's. These

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[1] For the rigorous geometric development of the model, see: Kelvin Lancaster, "The Heckscher-Ohlin Trade Model: A Geometric Treatment", Economica, New Series, Vol. XXIV (February, 1957), pp. 19-39. See also: Jagdish Bhagwati, "The Proofs of the Theorems of Comparative Advantage", Economic Journal, Vol. LXXVII (March, 1967), pp. 75-83.

[2] Bertil Ohlin, Interregional and International Trade (Cambridge: Harvard University Press, 1933).

suggest that, at a static level, the pattern of comparative advantage in international trade can be explained mainly by the differences in natural resource endowments, research and development activities, national economic sizes, and per capita income levels. Before turning to these, a review of the empirical work on the formal Heckscher-Ohlin model will be presented.

1.1 The Leontief Paradox

The empirical prediction of the contemporary Heckscher-Ohlin model is that patterns of international trade can be explained by differences in the relative endowments of capital and labour among countries. The two important corollaries of the theory are the factor-price-equalization theorem[1] and the Stolper-Samuelson theorem.[2]

The most controversial of all empirical findings is the one by Leontief.[3] He starts with the common sense argu-

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[1] Paul A. Samuelson, "International Trade and the Equalization of Factor Prices", Economic Journal, Vol. LVIII (June, 1948), pp. 163-84; and "International Factor Price Equalization Once Again", Economic Journal, Vol. LIX (June, 1949), pp. 181-97.

[2] W. Stolper and P.A. Samuelson, "Protection and Real Wages", Review of Economic Studies, Vol. IX (November, 1941), pp. 58-73; reprinted in Readings in the Theory of International Trade (Homewood, Illinois: Richard D. Irwin, 1950), pp. 333-357.

[3] Wassily W. Leontief, "Domestic Production and Foreign Trade: The American Capital Position Re-examined", Proceedings of the American Philosophical Society (September, 1953), pp. 332-349.

ment that the United States should have a comparative advantage in capital-intensive products since she is relatively better endowed with capital than her trading partners. On the basis of the 1947 input-output structure of the American economy, he computes for various industries the direct and indirect capital and labour required to produce a given dollar value of output. He then calculates the effects on capital and labour use of a given reduction in both the United States imports and exports. He examines the case in which this reduction is to be achieved by an equal proportional cut in each export and import commodity, so that the relative commodity composition of exports and imports remained unchanged. Reasoning in the same fashion as Stolper and Samuelson[1] do, he holds that if the Heckscher-Ohlin theorem is correct, the export contraction must release relatively more capital and less labour than will be absorbed by the import replacement industries at the going prices.

The results, however, do not support this position. The reduction in American exports embodied less capital and more labour than would be required to expand domestic output to provide an equivalent amount of competitive imports. The United States import replacement industries required more capital relative to labour than did her export industries.

Leontief tries to resolve the apparent contradiction

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[1] Stolper and Samuelson, "Protection and Real Wages", op. cit., p. 346.

by urging that the United States is relatively better supplied with "labour efficiency units" than other countries when one takes into account the superior physical effectiveness of the American labour.[1] He points to entrepreneurship, superior organization and favorable environment as the possible reasons for higher productivity of the American worker.[2] Thus, although the United States has more capital per worker than the other countries, if the supply of labour is expressed in "efficiency units" the United States will be found to be relatively rich in labour and scarce in capital. This argument, however, is not valid because it already assumes that the Heckscher-Ohlin theorem provides a valid explanation of the American pattern of trade when, in fact, the question being asked is precisely whether it does.[3]

Due to the absense of comprehensive statistical information, Leontief leaves out of his account the third factor of production, natural resources. In his second report,

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[1] Leontief, "Domestic Production", op. cit., p. 344.

[2] Ibid., p. 345.

[3] Jagdish Bhagwati, "The Pure Theory of International Trade: A Survey", Economic Journal, Vol. LXXIV (March, 1964), reprinted in Surveys of Economic Theory (New York: St. Martin's Press, 1966), pp. 156-239, p. 179. See also the recent work: Mordechai Kreinin, "Comparative Labor Effectiveness and the Leontief Scarce-Factor Paradox", American Economic Review, Vol. LV (March, 1965), pp. 131-140.

greater attention is paid to this point.[1] The relative factor intensities may not mean the same thing when we include the third factor in the calculations, i.e., capital intensive product in a two factors model may well be natural resource intensive in a three factors model.[2]

Ellsworth[3] argues that Leontief's formulation of the basic hypothesis is incorrect. The larger amount of capital per worker in the United States implies that the capital intensity of the American import replacement industries is irrelevant to the comparison since the American import competing products will be more capital intensive than actual imports from the rest of the world. But this criticism is not valid if the basic assumption of identical production function and irreversible factor intensities is used.

Leontief used the restrictive assumption of fixed factor coefficients of production. The method was criticized by Valvanis.[4] His argument is that Leontief's input-output

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[1] Wassily W. Leontief, "Factor Proportions and the Structure of American Trade: Further Theoretical and Empirical Analysis", Review of Economics and Statistics, Vol. XXXVIII (November, 1956), pp. 386-407, p. 395.

[2] S. Mukerji, Factor Endowments and International Trade (New Delhi: Asia Publishing House, 1962), p. 82.

[3] P.T. Ellsworth, "The Structure of American Foreign Trade: A New View Examined", Review of Economics and Statistics, Vol. XXXVI (August, 1954), pp. 280-81.

[4] Stefan Valvanis, "Comment", Review of Economics and Statistics, Vol. XL, Supplement (February, 1958), pp. 111-113.

approach with fixed input coefficients is incompatible with a world trade equilibrium in which every country gains from trade, full employment exists, and the introduction of trade increases the output of some commodities and reduces others. The fixed coefficients of production model, when adhered to strictly, normally implies less than full employment of one or more factors.

Recently, Brecx[1] pointed out that when the United States increases its competitive imports by one million dollars' worth, preserving at the same time the balance of payments equilibrium, it does not necessarily have to increase its exports by one million dollars' worth. One must compute and compare the quantities of capital and labour directly and indirectly required to produce in the United States one million dollars' worth of competitive imports on the one hand, and on the other hand the amount of exports which equilibrates exactly the balance of payments. Brecx shows that, when this is done, the Leontief paradox disappears.[2]

Besides Leontief's work, there are other empirical studies done to test the relevance of the formal Heckscher-

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[1] Paul Brecx, "Leontief Paradox", Review of Economics and Statistics, Vol. XLIX (November, 1967), pp. 603-607.

[2] Ibid., p. 603.

Ohlin theorem to reality. Tatemoto and Ichimura[1] employed the same input-output technique as was used by Leontief and studied the Japanese trade structure of 1951. Their first finding was that an average million yen's worth of Japanese exports embodied more capital and less labour than would be required for the domestic replacements of competitive imports of an equivalent amount.[2] This was explained by Tatemoto and Ichimura in the following way.

> Since about 25 percent of Japanese exports went to advanced and 75 percent to underdeveloped countries in 1951, it is not surprising to find that on balance Japan appears as a "capital abundant" country in comparison with the rest of the world.[3]

Another important finding of their study is that the capital-labour ratio of Japanese exports to the United States is lower than for her total exports, which implies that Japan exported relatively less capital intensive goods to the United States in 1951.[4]

Wahl[5] used the 1949 input-output data for Canada and

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[1] Masahiro Tatemoto and Shinichi Ichimura, "Factor Proportions and Foreign Trade: The Case of Japan", Review of Economics and Statistics, Vol. XXXXI (November, 1959), pp. 442-446.

[2] Ibid., p. 445.

[3] Ibid.

[4] Ibid., p. 446.

[5] Donald F. Wahl, "Capital and Labour Requirements for Canada's Foreign Trade", Canadian Journal of Economics and Political Science, Vol. XXVII (August, 1961), pp. 349-358.

arrived at a general conclusion that Canadian exports in 1949 were capital intensive while imports were labour intensive. In Wahl's study the labour data referred to wages and salaries, and capital excluded inventories and land. In Leontief's study for the United States, the labour data were in terms of man-years, and capital included inventories and land.

Wahl also projected the factor requirements for 1970 Canadian trade in 1949 dollars. After being adjusted for price changes during the period 1949-55, the estimated trade data of the Caves-Holton study[1] were used as the basis for the projection. The conclusion was that exports would be capital-intensive while imports would be by a slight margin labour intensive.[2] Wahl assumed that the Canadian flow matrix would not change substantially between 1949 and 1970, and that the 1949 direct capital and labour coefficients would be valid in 1970. Therefore, the results require many qualifications.

Due to the large portion of Canadian trade with the United States, it would be expected that Canadian exports to be labour intensive, and imports capital intensive. But Wahl's

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[1] R.E. Caves and R.H. Holton, The Canadian Economy: Prospects and Retrospect (Cambridge, Massachusetts: 1959).

[2] Wahl, "Capital and Labour Requirements", op. cit., p. 354.

results showed the opposite.

A recent study by Wilkinson makes an important point:

> ...if relative factor-endowment characteristics of Canadian trade in manufactures are going to be examined, it is essential not to confine oneself to a consideration of only physical capital and units of homogeneous labour. The skills and education of the labour force and the relevance of Canadian natural-resource inputs must be considered as well.[1]

Wilkinson employs manufacturing value-added data to measure differences between the physical- and human-capital intensity of production among manufacturing industries.[2] Labour is defined as uneducated and untrained workers. The dollar value of the wage-salary share of manufacturing value added per employee is taken as an indicator of the average human capital invested in each worker. The non-wage salary share of manufacturing value added per employee is used as an indicator of the importance of physical capital in the production process. A natural-resource-intensive industry is defined as one in which at least 50 percent of the total value of material inputs is from the primary sector of the Canadian economy.[3]

His findings are that most of the primary-manufacturing

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[1] Bruce W. Wilkinson, Canada's International Trade: An Analysis of Recent Trends and Patterns, (Montreal: The Private Planning Association of Canada, 1968), p. 106.

[2] Ibid., p. 89.

[3] Ibid., p. 94.

exports are both natural-resource- and physical-capital-intensive, and that the secondary-manufacturing exports are human-capital-intensive.

In explaining the Canadian primary-manufacturing exports, Wilkinson postulates that capital is by far the most mobile of the factors of production and consequently tends not to be a major determinant of trade flows,[1] and that it is the presence in large quantities of high-quality resource inputs which enables the export of primary-manufactured goods.[2]

He finds for secondary manufacturing that Canada appears to be exporting human-capital-intensive commodities, largely to the United States, even though Canada is normally considered to be relatively less well-endowed with human capital than is the United States.[3]

Wilkinson suggests an answer to this paradox:

> Introducing the technological-gap theory to "explain" trade in secondary manufacturing therefore enables us to avoid letting this apparent paradox become a major academic issue.[4]

Now I would like to turn to the discussion of the new theories of trade in the next section.

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[1] Ibid., p. 107.

[2] Ibid., p. 107.

[3] Ibid., p. 108.

[4] Ibid., p. 108.

1.2 New Explanations

In 1956 Kravis[1] developed the "availability" hypothesis, which emphasized the importance of scarcity of natural resources and temporary monopolies acquired by manufactures in some nations through producing new products or differentiating older ones. The reason why international trade tends to be confined to goods which are not available at home is, according to Kravis, because tariff policies, transport costs, cartelization, etc., tend to eliminate from trade those commodities which can be made available at home through domestic production.

He observes that a significant portion of high capital-content imports by the United States are products of natural resources that have become relatively scarce in the United States and which American capital has therefore developed abroad. The explanation of the Leontief paradox in this context lies in the availability of certain natural resources abroad and their growing scarcity at home. In the trade of highly manufactured goods, Kravis argues, national product differentiation is more relevant. Even when individual brands are unknown, preference for a particular brand may be subordinate to the preference for the product of the particular nation. The United States would be exporting products not

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[1] I.B. Kravis, "Availability and Other Influences on the Commodity Composition of Trade", Journal of Political Economy, Vol. LXIV (April, 1956).

because she has a long-run comparative advantage in producing them but they are at the moment available only in the United States. Thus, the bases of the availability factor--natural resources, technological progress, and product differentiation--probably tends to increase the volume of trade. The theory appears attractive, but Kravis does not get down to stating precise, testable hypothesis.[1]

The fact that many of the United States imports are produced by American owned firms located abroad complicates the picture. American owned firms may tend to invest in primary products abroad due to their scarcity domestically. Buchanan[2] has suggested that if imports produced under those conditions were eliminated from the United States import replacement industries competing with the remaining imports would probably be more labour-intensive than exports.

In 1961 and 1962, Posner[3] and Arrow[4] respectively paid attention to the size of the production volume as the major

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[1] Bhagwati, "A Survey", op. cit., p. 182.

[2] Norman S. Buchanan, "Lines on the Leontief Paradox", Economia Internationale, Vol. VIII (November, 1955), pp. 791-794.

[3] M.V. Posner, "International Trade and Technical Change", Oxford Economic Papers, Vol. XIII (October, 1961), pp. 323-41.

[4] K.J. Arrow, "The Economic Implications of Learning by Doing", Review of Economic Studies, Vol. XXIX (June, 1962), pp. 155-73.

determinant of trade flows and developed the dynamic scale economies account. In Posner-Arrow approach, technology is the function of total past production volume. Dynamic economies of scale are essentially "learning-by-doing" economies. The more one produces the greater efficiency one would achieve by greater production experience. Kaldor's[1] modification emphasizes that learning takes "time". A small country which has been producing a commodity for seven years would be expected to have a superior technology to a country which has been producing only for two years regardless of the size of the accumulated total production volume.

In addition to the dynamic economies of scale, the static economies of scale have to be mentioned. The static economies of scale are essentially caused by imperfect divisibility of factors of production. The divisibility of factors is the function of the scale of production. Under the static economies of scale, the greater efficiency is achieved only by an increased scale of production.

Thus due both to the dynamic and to the static economies of scale, the greater efficiency in production is achieved as the scale of production is expanded, so that a country which has larger GNP and longer production experience might well have a comparative advantage in the production of

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[1] Nicholas Kaldor, "Comment", Review of Economic Studies, Vol. XXIX (June, 1962), pp. 174-92.

those goods that were innovated at home.

The Posner theory was elaborated and tested against the data on trade in synthetic materials by Hufbauer,[1] who developed a distinction between "technological gap" trade and "low wage" trade, the latter being the result of the gradual transfer of technological improvements to countries in which the products could be supplied more cheaply than in the country of their origin.

The new theories discussed so far all suffered from an absense of explanation of why technological innovations occur in some countries rather than in others. Both Linder[2] and Vernon[3] respectively attempt to answer the question.

Linder maintains that developments of manufactured products are associated with the distinct demand structure pertaining to the economy of a certain per capita income level. His model assumes non-homothetic indifference maps and different per capita income levels among countries. Linder's hypothesis states that per capita income differences are the most important single factor which determines the

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[1] G.C. Hufbauer, Synthetic Materials and the Theory of International Trade (Cambridge, Massachusetts: Harvard University Press, 1966).

[2] Linder, An Essay, op. cit.

[3] Raymond Vernon, "International Investment and International Trade in the Product Cycle", Quarterly Journal of Economics, Vol. LXXX (May, 1966), pp. 190-207.

intensity of trade in manufactured goods.

Vernon developed a theory of "product cycle" which provides hypothesis to answer the main questions about the genesis of innovations. The United States market is characterized by high income levels or high unit labour cost. Higher income creates new unfilled needs, which gives rise to the pioneer appearance of new products. The first producing facilities for such new product associated with high income will be located in the United States. In consumer goods, high cost of laundresses contributes to the origin of the drip-dry shirt. In industrial goods, high labour costs leads to the development of conveyer belt.

As the demand for a product expands, a certain degree of standardization usually takes place. If the product has a high income elasticity of demand, the demand in time will begin to grow quite rapidly in other relatively advanced countries such as those in Western Europe. Once the market expands in such an advanced country, entrepreneurs will begin to ask themselves whether the time has come to take the risk of setting up a local producing facility. If economies of scale are being fully exploited, the principal differences between any two locations are likely to be labour costs. Thus it may prove wise for the international firm to begin serving a third country from the new location. If labour cost differences are large enough to offset transport costs, the product will be exported back to the United States. In

addition to low wage costs, the availability of relatively low capital costs and an access to a protected large market for the product are conceivable as further incentives to transfer the production location of an innovation to another country.

Hence, according to the Vernon theory, the United States would export labour-saving products associated with high income in the early stages of innovation, and would import them later from countries of cheaper labour costs.

Now, as we have seen, Linder explicitly and Vernon implicitly assumed non-homothetic indifference maps. The contemporary Heckscher-Ohlin model assumes international identity of tastes, but it does not specify the shape of the community indifference map. Romney Robinson[1] has pointed out that a country may not export the product requiring relatively more of its plentiful factor even when the two countries in the trading system have identical consumption indifference map, provided that the common preference maps are not homothetic and that one country has a higher income than the other.

Thus, what has been suggested by the new theories is that the economies of scale, natural resource endowments, the

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[1] Romney Robinson, "Factor Proportions and Comparative Advantage: Part I", Quarterly Journal of Economics, Vol. LXX (May, 1956), pp. 169-192.

education or skill of the labour force, and per capita income levels have important implications for the pattern of international trade in addition to just homogeneous labour and physical capital endowments.

The crucial question is how applicable those new explanations are to the actual trade of our day. My thesis is interested in testing the statistical significance of the per capita income differences emphasized by Linder. The next chapter elaborates the theoretical framework of Linder's model.

CHAPTER II

LINDER'S THEORY

A country's absolute volume of exports to any one country would be largely dominated by the size of the trading partner. Japan's exports to the United States, for instance, are much larger in absolute terms than her exports to the Republic of Korea, due mainly to the fact that both population and GNP are so much bigger in the United States than in Korea. But the share of Japanese exports in American GNP may be much smaller than the share of Japanese exports in Korean GNP. Or, the American per capita imports from Japan may be much smaller than Korean per capita imports from Japan

Linder's original hypothesis states: "the more similar the demand structures of two countries, the more intensive, potentially, is the trade between countries".[1]

There are three theoretical issues involved in the hypothesis. First, what should be used as an index of similarity of demand structures between countries? Second, what should be used as an index of the intensity of trade between countries? Third, why should the trade between

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[1] Linder, An Essay, op. cit., p. 94. The underline is mine.

countries with similar demand structures be potentially most intensive?

Linder gives his own answer to each of them. To the first, he replies, "the similarity of average income levels can be used as an index of similarity of demand structures".[1] To the second, he suggests one country's average propensity to import from another as an index of trade intensity. He writes, "if we divide U.S. imports from Sweden by the U.S. GNP, we obtain a measurement of how much each dollar unit of the U.S. trades with Sweden".[2] To the third, Linder says, "the answer is simple: the same forces that give rise to trade within each of the countries create trade between them. There is no difference between trade among countries with the same per capita incomes and trade within a country".[3]

Linder's hypothesis applies only to the trade in manufactures.[4] Linder discussed trade in both consumer goods and capital goods in his text, but he did not spell out his

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[1] Ibid., p. 94.

[2] Ibid., p. 111.

[3] Ibid., p. 102.

[4] Linder retains the factor proportions approach for the analysis of trade in primary products. A country abundantly supplied with a natural resource is assumed to have a comparative advantage in the exploitation of the resource.

theory in a rigorous manner. His model for consumer goods will be developed in greater detail in the following pages, and his argument for trade in capital goods will be investigated later in this chapter.

First of all, the following two concepts should be given clear definitions.[1]

> "Structure of demand" means the kinds of goods demanded and the proportion in which they are demanded by an economic unit.
>
> "Representative" structure of demand of a country means the structure of demand of an individual with an average income of the country.

The simplifying assumptions that I consider as essential for the purpose of examining Linder's hypothesis about the trade in manufactured consumer products are:[2]

1. All goods can be classified in accordance with some precise quality classifications.
2. The indifference preference system is identical for all individuals across national borders.
3. The indifference curves are not homothetic but are skewed in some systematic manner.
4. The per capita income levels differ from country to country.

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[1] Linder shied away from defining them clearly yet used the concepts throughout his Chapter III.

[2] None of the assumptions except (1) were explicitly stated by Linder, but were rather implicit in the discussion.

5. The average income group is the largest in number and the sum of all incomes of this group composes the major portion of national income of the country.

Assumption (1) was explicitly given by Linder in the earlier stage of his discussion.[1] (1) and (2) are indeed very strong assumptions, but they are helpful for the purpose of exposing the core of Linder's argument. They will be relaxed later when product differentiation is introduced into the argument. The relaxation of the assumptions does not affect the main argument.

Assumption (3) means that there is a systematic shift in the individual's demand structure as the level of income changes. Hicks' income consumption path is not a straight line from the origin. The demand for a certain good may decrease (e.g., an inferior good), may even disappear, may remain constant, or may increase either at an increasing or diminishing rate as the level of income rises. Linder suggests that higher income would give rise to the appearance of the demand for new products, by pointing out that, given a certain budget constraint, a consumer would tend to diversify his consumption as much as possible.[2]

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[1] Linder, An Essay, op. cit., p. 95.

[2] Ibid., p. 96.

A national economy consists of individuals with identical preference systems, with different budget constraints, and, therefore, with different demand structures. By assumption (5), the demand structure of an individual with average income level of a country is a "representative" demand structure of the country. Some of the special items demanded by a minority group in the country may not be listed in the goods demanded by an average income man. The demand for Cadillacs in Saudi-Arabia is unrepresentative of the country's demand.

By assumption (4), average income levels differ from country to country. Therefore, from the above discussion, representative demand structure would also differ from one country to another.

On the basis of these five assumptions, we can conclude that the closer the per capita income levels, the greater the number of goods for which demand overlaps between countries, or that the greater the per capita income differences, the smaller the number of goods for which demand overlaps between countries. This is the very foundation of the whole theoretical discussion of Chapter III of Linder's book.

Linder then introduces two concepts; potential exports and potential imports. The range of potential imports of a country is determined by the structure of demand of the country. Linder writes, "It is self-evident that internal

demand determines which products may be imported".[1]

The range of potential exports of a country is somewhat narrower than the range of domestic demand. He writes, "It is a necessary but not a sufficient condition that a product be consumed (or invested) in the home country for this product to be a potential export product".[2] He goes on to maintain that "it is really what we refer to as 'representative demand' that is necessary for a good to be a potential export product".[3] Because, "It will be evident that, although, for instance, the demand for Cadillacs in Saudi-Arabia is not totally absent, this kind of unrepresentative demand is not sufficient to turn luxury cars into potential export products for Saudi-Arabia".[4]

In summary, the range of potential imports is determined by internal demand, and the range of potential exports is determined by the representative demand of the country concerned. Hence, "we thus find that the range of potential exports is identical to, or included in, the range of potential imports".[5]

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[1] Ibid., p. 91.

[2] Ibid., p. 87.

[3] Ibid., p. 87.

[4] Ibid., p. 87.

[5] Ibid., p. 91.

Thus the closer the per capita income levels of two countries, the more similar the representative demand structures of the two countries, and so the greater will be the number of goods for which demand overlaps and in which trade can take place. We may rewrite Linder's hypothesis: the closer the per capita income levels of two countries, the more intensive, potentially, is the trade between countries.

Let us recall that Linder suggested a country's average propensity to import from another as an index of trade intensity between the two. Per capita imports of a country from another would be a more appropriate index of trade intensity in the model in which the similarity of per capita income level is used as an index of the similarity of demand structures. Thus, we may further rewrite Linder's hypothesis: the closer the per capita income levels of two countries, the greater, potentially, is the per capita imports of a country from another.

Linder emphasizes that there must be a home market for an export good. He contends that the decision to take up production of any particular good is likely to be generated by clearly decernible economic needs at home, and that only after a considerable period of production for the domestic market will the entrepreneur become aware of the profit offered by producing for foreign countries.[1] To support this

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[1] Ibid., p. 88.

position, Linder goes on to duscuss the causes of invention and innovation. He argues that it is a country's own needs which are the mother not only of innovation but also of invention.[1]

> Research products as well as one-man efforts, aimed at inventions for commercial exploitation, are likely to be planned for the most obvious needs--the domestic ones. The resulting products will suit the needs of the home market and will only gradually be tried on the export markets.[2]

In actual trade a country does not necessarily export all of its potential exports. Its range of actual exports is confined to those items in which it has a comparative advantage in production. As was reviewed in the last chapter, the main sources of comparative advantage in modern manufactured products among industrial countries are: (i) temporary monopoly of production due to a technological gap, (ii) product differentiation, (iii) lower production costs realized by greater economies of scale at home (due to larger population or larger production size, or to both), (iv) lower wage costs at home compared with abroad, and (v) higher education and skill levels of the labour force at home compared with abroad.

In order to introduce product differentiation into a picture we have to modify assumptions (1) and (2). If all goods can be classified in accordance with some precise quality

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[1] Ibid., p. 89.

[2] Ibid.

classifications, either two goods are identical or one is superior to the other. If everybody has an identical preference system, two individuals with the same income level will have identical demand structures. Thus, there would be no room for product differentiation under those assumptions if they were adhered to strictly.

The existence of product differentiation means that there are products which are identical in quality by some scientific standard but are idiosyncratic in brands, designs, countries of origin, etc. If there is product differentiation, the indifference preference systems of people would not be identical. Some particular person may have a special attachment to a Sony tape-recorder rather than a Philips one, even though the mechanical and electronic qualities of the two machines are the same. Thus, there are goods which cannot be classified by quality standards alone. To the extent that there is product differentiation and to the extent that individuals' demands are influenced thereby, the preference structures of individuals are idiosyncratic.

The introduction of product differentiation does not weaken but rather lends support to Linder's hypothesis. Linder discusses the case of national product differentiation. He cites an example; "Ships bringing European beer to Milwaukee take American beer to Europe."[1] The closer the per capita

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[1] Ibid., p. 102.

income levels, the greater the number of goods for which demand overlaps, and, therefore, the greater the number of goods in which product differentiations can take place.

In actual trade a number of trade-reducing forces come in to disturb the trade creating effects. Linder maintains that despite all cultural, political and natural disturbances to free trade, per capita income levels are still an important determinant of the intensity of trade in manufactured goods.[1]

Next I would like to turn to the discussion of capital goods trade.

In most treaties on the theory of international trade, the causes and nature of trade in capital goods have received little attention.[2] A given stock of capital equipment is assumed to exist, and the possibility of any net saving is ruled out.

This traditional approach is very inadequate in these days, when economic growth is such an important goal, especially for the less developed countries. Capital goods trade is a crucial part of the dynamic relationship between international trade and development. Part of the imports of investment goods into less developed countries is financed

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[1] Ibid., p. 108.

[2] In his survey article Bhagwati comments on the lack of analysis on this subject. (Bhagwati, "A Survey", op. cit.).

by international flows of capital funds, but a significant portion of this trade is financed by current foreign exchange earnings.

We are interested in the static aspect of trade in capital goods here, not in the dynamic aspect of it. Let us assume that there is no transfer of income or flow of capital funds internationally.

The capital good is a produced means of production which together with other factors, can be employed in producing either additional units of this capital good or the other consumption commodity.

Thus, at a static level, the structure of demand for capital goods is geered to the structure of demand for consumption goods, and to the technological nature of the production functions for both capital and consumption goods.

The structure of demand for consumer goods is by our assumptions strongly related to the level of per capita income. Production functions are non-identical among countries of different per capita income levels. In the country with a high per capita income, the education and skill levels of the labour force are high and the qualities of capital goods used are also high.

Linder points out that per capita income is to a certain extent determined by the existing stock of capital goods.[1]

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[1] Linder, An Essay, op. cit., p. 96.

He thinks that it is probable that the technical possibilities for qualitative variations in capital goods are at least as great as for consumption goods, that people on relatively lower per capita income levels select lower qualities of capital goods in order to be able to spread their available capital more evenly, and that people on relatively higher per capita income levels demand more sophisticated capital equipment.

In addition, the similar sort of demonstration effect would be working among profit seeking entrepreneurs (e.g., the use of computers) as among consumers, so that the demand structures of the entrepreneurs of two countries with close per capita income levels tend to be similar, given that both societies save the same portions of their income.[1]

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[1] The actual quantity of capital goods produced in any time period is a function of the preferences of the population for the consumption goods over their time horizons and the technological nature of the production functions for the two groups of commodities. In a world of perfect certainty in which future market exists, prices are stable and interest rates are known, a particular time pattern of investment would be selected by the community at the outset and followed during the entire accumulation process. However, if there is imperfect knowledge about the future, individuals will revise their accumulation plans as time passes and new information becomes available. A model based on the latter type of behavior was developed by Leontief. Wassily Leontief, "Theoretical Note on Time-Preference, Productivity of Capital, Stagnation and Economic Growth", American Economic Review, Vol. XLIV (December, 1959), pp. 1041-43. See also: F.M. Wasfield, "Time Preference and Economic Growth: Comment", American Economic Review, Vol. XLIV, (December, 1959), pp. 1037-41. Baldwin applies the same technique to explain the role of capital good in international trade from a dynamic point of view. Robert E. Baldwin, "The Role of Capital-Goods Trade in the Theory of International Trade", American Economic Review, Vol. LVI, (September, 1966), pp. 841-848. Baldwin showed that a relatively capital-scarce country would import the capital good, which was assumed to be uniformly capital-intensive compared to the consumption good, and export the consumption commodity.

Hence, if the capital goods are to be classified according to the quality classifications, the kinds of capital goods for which demand overlaps and in which trade can take place will be greater, the closer the per capita income levels are among countries.

CHAPTER III

MULTIPLE REGRESSION MODELS

A number of statistical models have been developed since World War II to analyze various aspects of international economic systems.[1] The present chapter surveys only those models that are primarily concerned with the static structure of international trade, and compares them with my model constructed for the testing of Linder's hypothesis elaborated in the preceding chapter.

Tinbergen[2] and Pöyhönen[3] separately formulated essentially the same multiple regression models for analyzing the trade flows between individual countries. Linnemann[4] modified and extended them later on. These models are

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[1] For a comprehensive survey of the models, see: Grant B. Taplin, "Models of World Trade", IMF Staff Paper, (November, 1967), pp. 433-53.

[2] Jan Tinbergen, Shaping the World Economy: Suggestions for an International Economic Policy (New York: The Twentieth Century Fund, 1962), see Appendix VI, pp. 262-293.

[3] Pentti Pöyhönen, "A Tentative Model for the Volume of Trade Between Countries", Weltwirtschaftliches Archiv, Band XC (1963), pp. 93-99.

[4] Hans Linnemann, An Econometric Study of International Trade Flows (Amsterdam: North Holland, 1966).

interested in the determinants of aggregate volume of trade flows between individual countries, while my model, which is geered to Linder's theory, is interested in the determinants of intensity of trade between them. The models will be surveyed in the order of the above.

First, consider Tinbergen's model.[1]

$$E_{ij} = a_o Y_i^{a_1} Y_j^{a_2} D_{ij}^{-a_3} N^{a_4} P_C^{a_5} P_B^{a_6} G_i^{-a_8}$$

where:

E_{ij} = exports of country i to country j

Y_i = GNP of country i

Y_j = GNP of country j

D_{ij} = distnace between country i and country j

N = dummy variable for neighbouring countries

P_C = dummy variable for Commonwealth preference

P_B = dummy variable for Benelux preference

$*G_i$ = Gini coefficient of export commodity concentration of the exporting country i

Tinbergen assumes the trade impediments to be of a

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[1] Tinbergen, Shaping the World Economy, op. cit., p. 266.

[*] Ibid., pp. 268-69. If a country exports only one commodity, the value of Gini index is 100. The more diversified the export package is, the lower is the value of the index. Refer: Michael Michaely, "Concentration of Exports and Imports: An International Comparison", Economic Journal, Vol. LXVIII (December, 1958), pp. 722-736.

stochastic nature, so that the deviations of the actual trade from the theoretically expected volume indicates that a country's exports are either receiving preferential treatment in importing countries (in case of a positive deviation) or being discriminated against (in case of a negative deviation).[1]

Tinbergen takes the logarithm of both sides of the equation and estimates the parameters by using the simple least squares method. The logarithmic linear equation implies that exports have a constant elasticity with respect to each of the explanatory variables. For example, one percent increase in the GNP of country j always results in an increase of a_2 percent in the exports of the supplying country i.

According to Tinbergen, actual volume of trade is a function of the potential supply of exports of an exporting country and the potential demand for imports of an importing country. The GNP of the exporting country represents the amount of exports a country is able to supply, and the GNP of the importing country represents the amount that can be sold to the particular country.[2]

The geographical distance is used as a proxy for transportation costs and his dummy variables take preference

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[1] Tinbergen, Shaping the World Economy, op. cit., p. 262.

[2] Ibid., p. 263.

relations into account.

Tinbergen carried out the calculations for the 1958 exports and imports data of 18 countries, and also for the 1959 exports data of 42 countries. He was primarily interested in knowing which countries show substantial negative deviations from the expected volume of trade. Some of his results will be discussed in the next chapter to be compared with other results.

Next, consider Pöyhönen's model.[1]

$$a'_{ij} = c\, c_i\, c_j\, e_{ii}^{\alpha}\, e_{jj}^{\beta}\, (1 - \lambda r_{ij})^{-\delta}, \qquad i \neq j$$

where:

a'_{ij} = estimate of the value of exports from country i i to country j

e_{ii} = national income of the country of export i

e_{jj} = national income of the country of import j

r_{ij} = distance of transportation between i and j

α, β = national-income elasticities of exports and imports

λ = transportation cost coefficient per nautical mile

δ = isolation parameter

c_i = export parameter of the country of export i

c_j = import parameter of the country of import j

c = constant

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[1] Pöyhönen, "A Tentative Model", op. cit., p. 95.

The model is essentially the same as that of Tinbergen, although it slightly differs from logarithmic linearity. The estimation principle applied by Pöyhönen was to minimize the logarithmic residual sum of squares. His model was applied to 1958 exports data of 10 European countries. His results will also be discussed briefly in the next chapter.

Now, I would like to discuss Linnemann's model in some detail. Linnemann attempts to explain factors affecting the size of the trade flow between two countries. He classifies the explanatory variables into three categories:[1]

1. factors indicating total potential supply of country i--the exporting country--on the world market,
2. factors indicating total potential demand of country j--the importing country--on the world market,
3. factors representing the "resistance" to a trade flow from potential supplier i to potential buyer j.

It can be expressed in the following equation form.[2]

$$X_{ij} = a_o (E_i^P)^{a_1} (M_j^P)^{a_2} (R_{ij})^{-a_3} \qquad (1)$$

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[1] Linnemann, An Econometric Study, op. cit., p. 8.

[2] Ibid., p. 34.

where:

X_{ij} = size of trade flow from country i to country j,

E_i^P = potential supply of exports of the exporting country i,

M_j^P = potential demand for imports of the importing country j,

R_{ij} = resistance factor between i and j.

Linnemann assumes that there is no international capital flows, that all countries are subject to exactly the same trade resistance in their dealings with the world market.[1] Under these assumptions potential supply of a country's exports is equal in value to its potential demand for imports on the world market. Hence, $E_i^P = M_i^P$.

Linnemann argues that potential supply and potential demand are each other's counterpart and therefore determined by the same forces.[2] He concentrates his discussion on potential supply.

He contends that a country's potential supply of exports is a function of the country's national income (Y) and of the ratio between production for the home market and production for the foreign market (DM/FM).

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[1] Ibid., pp. 9-11.

[2] Ibid., p. 9.

$$E_i^P = F\ (Y_i,\ DM/FM) \qquad (2)$$

The larger the Y_i, the larger the E_i^P. It is implied throughout his chapter 2 that the larger the DM/FM ratio, the smaller the E_i^P. Linnemann does not give any explicit explanation as to why it should be so.

Then he makes a bold assumption that the DM/FM ratio varies only with the population size and not with per capita income level of the country.[1]

$$(DM/FM)_i = g\ (N_i) \qquad (3)$$

Linnemann accepts by a priori reasoning the following principle:

> In principle, every country will try to produce as much of its requirements as possible at home, in order to avoid the transportation costs, etc.[2]

Thus, a country with a larger population size will export less

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[1] This is really a bold assumption. By employing this assumption, Linnemann in effect ignores all new theories of trade except scale economies account of Posner-Arrow type (not of Kaldor type). It is worthy to note that he is explicitly ignoring Linder's theory. He cites the following works as empirical evidences of the negligible effect of per capita income level upon DM/FM ratio. Simon Kuznets, Six Lectures on Economic Growth (Glencoe: The Free Press, 1959), pp. 94-95. Michael Michaely, Concentration in International Trade (Amsterdam: North Holland Publishing Company, 1962), p. 111.

[2] Linnemann, An Econometric Study, p. 13.

and import less due to the cheaper production cost achieved at home through greater economies of scale.[1] As economies of scale are reached in more products, more resources will be shifted from the production for foreign market to the production for domestic market.

Thus, in summary, the potential supply of exports of a country on the world market is a positive function of its national income (Y) and a negative function of its population size (N). Linnemann assumed away the effect of per capita income level upon the potential supply of exports, so that Y and N are statistically independent from each other. Therefore,

$$E^{P}_{i} = b_{o} Y_{i}^{b_1} N_{i}^{-b_2} \qquad (4)$$

Linnemann maintains that the demand of a country for potential imports on the world market is determined by the same variables in the same way. The effect of per capita income is negligible. The larger the population of the importing country, the smaller its potential demand for imports. The larger the national income of the importing country, the greater its potential demand for imports. Hence,

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[1] Ibid., p. 13. Note that in Posner-Arrow theory economies of scale had the trade stimulating effects, while in Linnemann they have the trade reducing effects. Linnemann cites the following works as empirical evidences of the existence of economies of scale. Bela Balassa, The Theory of Economic Integration (London: Allen and Unwin, 1962), p. 131. Hollis B. Chenery, "Patterns of Industrial Growth", American Economic Review, Vol. L (September, 1960), pp. 624-654.

$$M_j^P = b_3 \, Y_j^{b_4} \, N_j^{-b_5} \qquad (5)$$

Regarding the resistance factors, Linnemann emphasizes transport costs. Distance is used as a proxy variable to reflect the transport costs. Artificial impediments, such as tariffs and quotas are ignored. It is assumed that at any moment of time the artificial barriers are applicable to all trade flows more or less equally, and that departures from this regularity are randomly distributed and are accounted for by the error term in the regression. Therefore,

$$R_{ij} = b_6 \, D_{ij}^{b_7} \qquad (6)$$

where:

D_{ij} = distance between country i and country j.

Thus, by equations (4), (5) and (6), we may rewrite the basic equation (1) into the following form.

$$X_{ij} = s_o \, Y_i^{s_1} \, N_i^{-s_2} \, Y_j^{s_3} \, N_j^{-s_4} \, D_{ij}^{-s_5} \qquad (1)'$$

Various preference relations between countries are taken into account by Linnemann by incorporating dummy variables into his basic model.

Linnemann introduces an additional variable in Chapter 6 of his text. He contends that the flow of trade from country i to country j will be larger, the better the commodity com-

position of the exports of i fits in with the commodity composition of imports of j.[1] This is taken into account by the commodity composition variable (C_{ij}), for which Linnemann develops his own index formula.[2]

Linnemann applies the simple least squares method to his log linear regression equation to estimate the parameters for the data of 1959. The total number of trade flows studied are 6300, of which about 45 percent had a value less than $100,000, which are recorded as zero in trade statistics. Highlights of his results will be discussed in the next chapter.

Lastly I would like to discuss my econometric models. The final form of Linder's hypothesis to be tested is: the closer the per capita income levels of two countries, the greater, potentially, is the per capita imports of a country from another.

I would like to test it against the data of per capita imports of 15 highly industrialized countries from Japan. The test will be carried out in two ways; first in terms of their aggregate per capita imports from Japan, and then in terms of their disaggregated per capita imports from Japan for

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[1] Linnemann does not explain why one country's commodity composition of exports may be similar or dissimilar to that of imports of the importing country. Linder, as we saw in the last chapter, maintains that it is determined by per capita income levels of countries.

[2] Linnemann, An Econometric Study, op. cit., pp. 140-43.

each of the commodity groups.[1]

It should be noted that in my models the level of per capita imports of a country from another is used as an index of trade intensity and that the degree of per capita income difference between them is used as an index of the similarity of commodity compositions of supply of exports of the exporting country and demand for imports of the importing country.[2]

The models reviewed in the preceding pages were all interested in the flows of trade between countries, but my models are interested in the intensity of trade between them.

Tinbergen pointed to the effect of export commodity concentration of the exporting country upon the flow of trade. He argued that the more diversified the export package is, the greater is the flow of exports from a country to another. Linnemann argued that the flow of trade from country i to country j would be larger, the better the commodity composition of the exports of i fits in with the commodity composition of the imports of j. However, why one country's export package

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[1] In the models reviewed in the preceding pages, all trade flows between sample countries were to be studied, while in my models only per capita imports of the sample countries from Japan will be studied.

[2] The effect of per capita income levels was completely assumed away in Linnemann's model, which incorporated the commodity composition variable. On this basis Linnemann assumed the statistical independence of national income and population variables. This assumption, however, cannot be justified if his commodity composition variable is affected by the per capita income levels as was suggested by Linder's theory.

is relatively more diversified or concentrated than others, and why one country's commodity composition of exports may be similar or dissimilar to that of imports of the importing country, were left unexplained by them. It is to those questions that Linder's theory provides an explanation.

I have two models; one is the aggregate model, and the other is the disaggregated one by commodities.[1]

$$X_j/N_j = K\,|y_j - y|^{-a_1}\, G_j^{-a_2}$$

$$X_{ij}/N_j = k\,|y_j - y|^{-b_1}\, G_j^{-b_2}\, T_{ij}^{-b_3}$$

where:

X_j = jth country's total imports from Japan
X_{ij} = jth country's imports of ith commodity from Japan
N_j = population size of jth country
y_j = per capita income level of jth country
y = per capita income level of Japan
G_j = geographical distance between Japan and jth country
T_{ij} = nominal tariff rate (%) on imports of i by j
K,k = constants

The price variable is omitted from the models, since

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[1] The logarithmic-linear functional form was used, since it gave much better fit of the regression in each of the cases.

mine is a cross-section study, using the data for each sample country at the same point in time. Each country is facing the same set of prices of Japanese exports exclusive of freight and insurance.

The geographical distance between Japan's port of export and jth country's port of import implicitly approximates the transportation costs, including the freight and insurance fees and time necessary for shipments and the need to maintain inventories because of the distance between the supplier and the purchaser. This is the same technique as was used by Tinbergen, Pöyhönen and Linnemann. Japan is a country which is severed from other countries by sea, so that the nautical distances can be used as a proxy for the transportation costs. The further away Japan is from the purchaser, the smaller will be the Japanese export intensity with him. This variable is incorporated into both aggregate and disaggregated models.

The nominal tariff rate on imports of ith commodity by jth country is incorporated into the disaggregated model as an independent variable. It is not included in the aggregate model since simple average rate of tariffs of a country for all import commodities means hardly anything unless

some justifiable weighting system is applied.[1]

The higher the tariff rate, the smaller the per capita imports of i by j. Ceteri's paribus, the extent to which X_{ij} is influenced by the tariff rate is determined by the price elasticity of j's demand for imports of i. The elasticity may be different from one country to another. But at least we can be sure about the direction of the effect of tariff on the import demand for highly manufactured goods.

The tariff also affects the terms of trade and the distribution of income, depending upon the conditions about elasticities of domestic and foreign offer curves, marginal propensity to import, and on how the tariff proceeds are distributed and spent.[2] To the extent that the tariff affects the distribution of income of a tariff imposing country and to the extent that tariff policies differ among countries, Linder's phyothesis is weakened.

The effect of economies of scale can be incorporated into my disaggregated model by taking some measure of total

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[1] There are numerous ways of calculating tariff averages: for example, by weighting duties with the country's own imports. This method has been used, in a report of the Joint Economic Committee of the U.S. Congress to compare the restrictiveness of tariffs in developed countries. Bela Balassa suggests to weigh tariffs by the value of world trade, in his Trade Liberalization among Industrial Countries, (New York: McGraw-Hill, 1967), Chapter 3, p. 48.

[2] For a good opening theoretical discussion of this topic, see: Lloyd A. Metzler, "Tariffs, the Terms of Trade and the Distribution of National Income", Journal of Political Economy, Vol. LVII (February, 1949), pp. 1-29.

past production of the commodity concerned relative to that of other country. This was not done simply due to the difficulty of collecting the data. The effect of the levels of skills and education of the labour force has also been ignored here due to the same reason.

The models are applied to the imports data of 15 advanced countries for the year 1965. The parameters have been estimated by the simple least squares method. Seven Japanese export commodity groups will be studied by the disaggregated model.

The next chapter discusses the highlights of Tinbergen's, Pöyhönen's and Linnemann's results, and gives my results and interprets them.

CHAPTER IV

RESULTS AND THEIR INTERPRETATION

The table on the next page gives selected typical cases of Tinbergen's results. All parameters were of expected sign and significant.[1] An interesting aspect of the results obtained for parameters a_1 and a_2 is that in all calculations--except in case C-3--the value of a_1 was about 0.1 higher than the value of a_2.

This systematic discrepancy between a_1 and a_2 by itself seems to suggest that the total export volume of country i to country j depends somewhat more on the GNP of the exporting i than on the GNP of the importing j. Tinbergen himself did not pay any particular attention to this point, but Linnemann attempts to offer an explanation later. It also implies that there is no equilibrium in the balance of trade

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[1] In calculation A, Tinbergen mentions that although the three dummy variables were all positive, as they should be, only the one representing the Commonwealth preference made a statistically significant contribution to the explanation of the export flow at 99.7 percent level of significance. He thinks that this illustrates the dominant role played by the first three variables, exporters' and importers' GNP and distance. However, it seems to me that 99.7 percent level of significance is a very stiff standard. All the three dummy variables were significant at 95 percent level of significance.

TABLE 1

TINBERGEN'S RESULTS

$$\log E_{ij} = a_o + a_1 \log Y_i + a_2 \log Y_j + a_3 \log D_{ij} + a_4 \log N + a_5 \log P_C + a_6 \log P_B + a_8 \log G_i$$

(-) (-)

Case	a_0	a_1	a_2	a_3	a_4	a_5
A-3	-0.4451	0.7357	0.6183	-0.5570	0.0191	0.0496
		(0.0421)*	(0.0422)	(0.0473)	(0.0082)	(0.0111)
C-1	-0.6555	1.0318	0.9647	-0.9228		
		(0.0428)	(0.0428)	(0.0657)		
C-2	0.4927	0.8569	0.9682	-0.8633		
		(0.0593)	(0.0424)	(0.0664)		

* Figures in the Parenthesis are standard errors.

TABLE 1--Continued

Case	a_6	a_8	R	Year	No. of Countries	No. of Observations
A-3	0.0406 (0.0272)		0.8437	1958	18	306
C-1			0.8039	1959	28	756
C-2		-0.7779 (0.1843)	0.8090	1959	28	756

E_{ij} = exports from country i to country j

Y_i = GNP of country i

Y_j = GNP of country j

D_{ij} = distnace between i and j

N = dummy variable for neighbour countries

P_C = dummy variable for Commonwealth countries

P_B = dummy variable for Benelux countries

G_i = Gini coefficient of export commodity concentration of i

A = predominantly advanced countries

C = includes a number less-developed countries

between two countries with different levels of GNP.[1] If a_1 is larger than a_2 large countries (in terms of GNP) will always export more to small countries than they import from them; this leads to a positive balance of trade for the bigger countries and a negative balance for the smaller ones.

If we assume that, by and large, trade balances should be in equilibrium, it may be stated that the trade flow equation resulting from Tinbergen's calculations overestimates the normal theoretical exports of the bigger countries (in terms of GNP) and underestimates the exports of the smaller countries (i.e., underestimates the imports of bigger countries).

Calculation C-2 is the only case in which the value of a_1 is lower than that of a_2. Tinbergen suspects, how-

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[1] $X_{ij} = a_o Y_i^{a_1} Y_j^{a_2}$ $\quad \sum_j X_{ij} = a_o \sum Y_i^{a_1} Y_j^{a_2}$

$X_{ji} = a_o Y_j^{a_1} Y_i^{a_2}$ $\quad \sum_j X_{ji} = a_o \sum_j Y_j^{a_1} Y_i^{a_2}$

Therefore,

$$\sum_j X_{ij} - \sum_j X_{ji} = a_o \sum (Y_i^{a_1} Y_j^{a_2} - Y_i^{a_2} Y_j^{a_1})$$

Hence, when $a_1 = a_2$

$$\sum_j X_{ij} - \sum_j X_{ji} = 0$$

ever, the existence of intercorrelation between the GNP of the exporting country and the fourth explanatory variable, G_i . A higher GNP generally implies a more diversified export structure. The intercorrelation was not very high (-0.54), but it was sufficiently significant to cast doubt upon the estimates of a_1 and a_2 .[1] No conclusive interpretation was made by Tinbergen about the effect of G_i . Whether the greater value of a_2 than that of a_1 in calculation C-2 was caused by the introduction of a new variable G_i or not was left unexplained by Tinbergen.[2]

The negative sign of a_8 means that an increase in commodity concentration leads to a smaller flow of exports. In other words, the more diversified the export structure, the greater the export volume.[3]

Tinbergen computed the deviations of actual trade from theoretical trade. This was done first for each trade flow individually; subsequently, these deviations were totaled for each exporting country and each importing country. Along these lines, figures for total export deviations and

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[1] Tinbergen, Shaping the World Economy, op. cit., p. 290.

[2] Linnemann attempts to explain this point later.

[3] In Linder, higher per capita income of a country implied the more diversified representative demand structure, and, hence, a more diversified potential supply of exports structure.

total import deviations were derived. Substantial deviations were to be expected because of the existence of many types of trade impediments (or occasionally trade stimuli) with varying degrees of effectiveness.

The deviation of actual from calculated total imports of a country may be due to several causes. A positive deviation may be due to a positive deviation of her actual exports from theoretical exports (e.g., preferential treatment of the exports of the country concerned), to the running down of previously accumulated stocks of foreign exchange by the country, to a positive service balance, or to a net inflow of new capital from abroad, or amortizations. A negative deviation may be due to a negative deviation on the export side (most likely to be caused by discriminatory treatment of the exports of the country concerned), to import restrictions imposed by the importing country itself (e.g., in order to build up foreign exchange reserves, or to obtain foreign exchange for debt), to a negative service balance, or to a net outflow of capital to countries abroad, or amortizations.[1]

Tinbergen suggests that the role of capital flow is of greater importance than that of service in explaining deviations.[2] In the year under consideration, there was a

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[1] Tinbergen, Shaping the World Economy, op. cit., p. 291.

[2] Ibid., p. 292.

substantial flow of capital from the developed countries to the newly developing countries of the world. This apparently enabled the developing countries to import more than they could have imported on the basis of export proceeds alone. Positive deviations could be expected in the developing countries on the import side and in the developed countries on the export side.

It is difficult to quantify the effects of service balances and capital flows on the volume of imports without going into a large amount of detailed work. Consequently Tinbergen tentatively suggests that for all developing countries together, the net effect seems to be such as to allow a deficit on the commodity trade balance, i.e., a higher level of imports than would follow from the export level.[1]

Pöyhönen's results are shown in the table on the following page. His samples were 10 European countries, and thus no underdeveloped countries were included. He carried out only one calculation, which showed approximately equal values of parameters for national incomes of exporting country i and importing country j. If we assume that, by and large, trade balances should be in equilibrium, it may be stated that the trade flow equation resulting from Pöyhönen's calculations rightly estimates the normal theoretical exports of the bigger countries (in terms of GNP) as well as the exports of

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[1] Ibid., p. 292.

TABLE 2

PÖYHÖNEN'S RESULTS

$$\log a'_{ij} = \log C + \log C_i + \log C_j + \alpha \log e_{ii} + \beta \log e_{jj} + \delta \log (1 + \lambda r_{ij})$$

log C	α	β	λ	δ	R	Year	No. of Countries	No. of Observations
-3.818	0.518	0.504	0.00157	-1.817	0.94	1958	10*	90

a'_{ij} = exports from country i to country j

e_{ii} = national income of i

e_{jj} = national income of j

r_{ij} = distance of transportation between i and j

α, β = national income elasticities of exports and imports

λ = transport cost coefficient per nautical mile

δ = isolation parameter

C_i = export parameter of i

C_j = import parameter of j

C = constant

In the model, only the common constant C was estimated. The values of C_i and C_j were determined afterwards with the aid of the estimation error ε_{ij}.

* All European countries.

smaller countries (in terms of GNP) among European countries. Thus, Pöyhönen thinks that his results indicate the bilateral balance of trade amond European countries, since the value of the parameter α is approximately equal to that of the parameter β.[1]

Pöyhönen does not give the standard errors or t-values to test the significances of the regression coefficients with.

Next I would like to turn to the discussion of the highlights of Linnemann's study. Like Tinbergen, Linnemann carried out calculations with both export and import data, but found no substantial differences in the results of the two. He also carried out computations with both real and nominal GNP figures, but found no substantial differences between them either.

The total number of observations were 6300. The trade flows less than $100,000 constituted around 45 percent of all observations. In the trade statistics concerned, the smallest unit reported was $0.1 million (which may actually have been attained by rounding off a figure bigger than $50,000).

This gives rise to a statistical problem for the logarithmic linear trade flow equation. It would make sense to put a small positive value instead of zero, also because in actual fact the value of the trade flow may very well have

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[1] Pöyhönen, "A Tentative Model", op. cit., p. 98.

been larger than zero. However, it makes a considerable difference what figures we put in instead of zero in the logarithmic equation. Linnemann suggested a solution to this problem. A practical and at the same time theoretically appropriate way out of this difficulty is to limit explicitly the estimation of the parameters of the trade flow equation to a certain range of values of the trade flow, i.e., to those values that are larger than the critical value $50,000. Linnemann also tried to improve the parameter estimates for many zero flows in a series of his calculations.

The inclusion of a number of less developed countries in the sample also poses a statistical problem. The variable to be explained is subject to fairly gross errors of measurement. Are these errors indeed normally distributed, with a constant standard deviation, as required for applying least-square regression? A constant standard deviation implies, in the case of a logarithmic linear equation, a measurement error which is proportionally the same at different absolute values of the trade flow.

A priori consideration suggests that measurement errors are likely to be more important in less-developed countries than in respect of countries having a longer statistical tradition. To the extent that trade flows with the developing countries, and particularly those between less-developed countries, are smaller than the trade flows between the economically advanced countries, the inaccuracies in measure-

ment would be somewhat more pronounced for the lower values than for the higher. This casts doubt upon the underlying assumption of homoscedasticity.

Linnemann carried out three sets of calculations. The table on the next page gives typical results from each set. AC-7, AC-23, and AC-31 are from the first, second and third set respectively. The results selected here were based on the import data and nominal GNP figures.

The first set was based on all non-zero flows: 3532 flows according to import statistics. The parameter values estimated in the first set did not explain the many zero flows among the basic data. All the parameters were of expected sign and were statistically significant. Linnemann used the beta coefficients[1] to find out which of the explanatory variables contributed most to a statistical explanation of the trade flows. A beta coefficient indicates the relative contribution that the variable in question makes to the explanation of the dependent variable. He found that the greatest contribution was made by the two GNP variables and

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[1] Linnemann, An Econometric Study, op. cit., p. 87.

$$\beta_1 = \frac{\sigma_{\log Y_i}}{\sigma_{\log X}} s_1 \ , \quad \sigma\text{: standard deviation}$$

See also: Robert Ferber and P.J. Verdoorn, Research Methods in Economics and Business, (New York: Macmillan, 1962), pp. 85-86.

TABLE 3

LINNEMANN'S RESULTS

$$\log X_{ij} = s_o + s_1 \log Y_i + s_2 \log N_i + s_3 \log Y_j + s_4 \log N_j + s_5 \log D_{ij} + s_6 \log P_{ij}^{uuc} + s_7 \log P_{ij}^{FFC} + s_8 \log P_{ij}^{PB}$$

Case	s_o	s_1	s_2	s_3	s_4	s_5	s_6	s_7	s_8
AC7	0.15	0.96	-0.18	0.82	-0.11	-0.77	1.23	2.25	6.55
		(0.02)	(0.03)	(0.02)	(0.03)	(0.03)	(0.15)	(0.27)	(0.64)
AC23	-0.08	1.42	-0.39	1.27	-0.46	-1.17			
		(0.02)	(0.03)	(0.02)	(0.03)	(0.02)			
AC31	1.11	0.73	-0.11	0.78	-0.13	-0.76			6.28
		(0.02)	(0.03)	(0.02)	(0.03)	(0.03)			(0.62)

Numbers in the parantheses are standard errors.

X_{ij} = exports from country i to country j

Y_i = GNP of i

N_i = population of i

Y_j = GNP of j

N_j = population of j

D_{ij} = distance between i and j

P_{ij}^{uuc} = preference for UK and UK associates

P_{ij}^{FFC} = preference for France and French associates

P_{ij}^{PB} = Portugese and Belgian colonial preference

TABLE 3--Continued

$$s_9 \log P_{ij}^{uc} + s_{10} \log P_{ij}^{FC} + s_{11} \log P_{ij}^{IFPB} + s_{12} \log P_{ij}^{u} + s_{13} \log P_{ij}^{F} + s_{14} \log P_{ij}^{uc}$$
$$+ s_{15} \log P_{ij}^{FC} + s_{16} \log C_{ij}$$

Case	s_9	s_{10}	s_{11}	s_{12}	s_{13}	s_{14}	s_{15}	s_{16}	R
AC7									0.804
AC23	1.51 (0.17)	3.85 (0.34)	4.97 (0.34)						0.802
AC31				3.55 (0.31)	3.48 (0.44)	1.00 (0.14)	1.43 (0.31)	0.61 (0.04)	0.810

P_{ij}^{u} = preference for UK and her associates

P_{ij}^{uc} = preference for UK associates between themselves

P_{ij}^{FC} = preference for French associates between themselves

P_{ij}^{UFPB} = UK, French, Portugese and Belgian preference in transactions with their "own" associated countries

P_{ij}^{F} = preference of France in transactions with her associated countries

C_{ij} = effect of the commodity composition of exports and imports of the trade partners

Linnemann uses different coefficient numbers for P_{ij}^{uc} and P_{ij}^{FC} in calculation AC-31, but the definitions of P_{ij}^{uc} and AC-31 not differ from those in AC-7.

the distance variable.[1] The other explanatory variables were of secondary importance.

The second set tries to improve the parameter estimates in such a way that some of the originally zero flows could be explained. Observations with an explained flow of $150,000 or more were included in the second set of computations. The total number of trade flows was 4831 in both import and export data. In the second set, it was found that the preferential trade effects were more pronounced in dealings between ex-motherland and ex-colony or ex-dominion than in trade relations between the non-metropolitan partners of a preferential trade area. The three dummy variables for preferential trade were given slightly different meanings from those of the first set. The absolute values of the regression coefficients were all much higher than in the first set, but the value of the correlation coefficient did not differ much. The second set provided us with the more realistic theoretical values for the smaller trade flows, but yielded theoretical values for the more sizable flows that were much too high. From this Linnemann suspects that the trade flow relation in fact may not be linear in logarithm but curvilinear.[2]

In the third set, an attempt was made to analyze the

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[1] Linnemann, An Econometric Study, op. cit., p. 88.

[2] Ibid., p. 79.

possible curvilinearity, but the appropriateness of the assumption of log-linearity could not be verified.[1] The basic data were those of the first set, i.e., only the flows reported in the foreign trade statistics. A new variable, C_{ij}, was added in the third set.

Now, in Linnemann's model, when $s_1 = s_3$ (national income parameters of the two countries) and $s_2 = s_4$ (population parameters of the two countries), trade balances would be in equilibrium for countries with different levels of GNP.[2] If $s_1 > s_3$ and $s_2 = s_4$, it implies an export surplus for the bigger countries (in terms of GNP).

In all calculations in the first and the second sets, the parameter of the exporting country's GNP was systematically

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[1] Ibid., p. 163.

[2] $$\sum_j X_{ij} = s_o \sum_j Y_i^{s_1} N_i^{s_2} Y_j^{s_3} N_j^{s_4} ,$$

$$\sum_j X_{ji} = s_o \sum_j Y_i^{s_3} N_i^{s_4} Y_j^{s_1} N_j^{s_2}$$

$$\sum_j X_{ij} - \sum_j X_{ji} = s_o \sum_j (Y_i^{s_1} N_i^{s_2} Y_j^{s_3} N_j^{s_4} - Y_i^{s_3} N_i^{s_4} Y_j^{s_1} N_j^{s_2})$$

Hence, when $s_1 = s_3$ and $s_2 = s_4$,

$$\sum_j X_{ij} - \sum_j X_{ji} = 0 .$$

larger than that of the importing country's GNP. No such strong systematic tendency was detected and the discrepancies were much smaller for population parameters.

Linnemann points out that bigger countries (in terms of GNP) are mostly the industrialized economies, and it could well be that the export surplus of these countries is due to the fact that their export availabilities fit in better with the import needs of the developing countries than the exports of the less-developed countries correspond to the import needs of the bigger nations.[1] If this were so, the systematic difference between s_1 and s_3 might disappear by the introduction of the C_{ij} variable.

In all of the third set of calculations, the systematic dominance of the exporting country's GNP over the importing country's GNP disappeared. This result led Linnemann to conclude that proportionality exists between trade and national product of each of the trade partners.[2]

Tinbergen introduced only the Gini coefficient of export concentration, and did not explain why the structure of supply of exports may be different from country to country. He indicated only that larger GNP might lead to lower value of G_i. Pöyhönen did not take the commodity composition variable into account. Linnemann introduced the variable which

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[1] Ibid., p. 147.

[2] Ibid., p. 211.

took into account the effect of the goodness of fit of commodity composition of supply of exports with the commodity composition of demand for imports upon the flow of trade. Linnemann, however, did not explain what determines the commodity composition of exports and imports.

On this point, let us recall that Linder suggested that the higher per capita income of a country implied a more diversified representative demand structure, and, hence, a more diversified potential supply of exports structure. Higher per capita income also meant a more diversified potential demand for imports structure. Linder further suggested that closer per capita income levels would give rise to the more intense trade relationship. Now, I would like to turn to the statistical test of Linder's proposition, which was explicitly ignored by Linnemann and tacitly ignored by Tinbergen and Pöyhönen.

Before presenting my regression results, first I would like to discuss the sources and measurements of the data used in my calculations.

The year selected for the study is 1965, by which year the modern Japanese export pattern had been fairly well established with the chemical industry as still a growing potential. The year 1965 was a convenient year for the collection of most of the data as well.

The Japanese export industries selected for analysis are the following. The SITC classifications are by Classifica-

tion of Commodities by Industrial Origin, Statistical Papers Series M, No. 43, (New York: Department of Economic and Social Affairs, Statistical Office of the United Nations).

SITC No.	Contents
5	Chemicals.
65 & 84	Textile Yarn, Fabrics, Made-up Articles and Related Products, and Clothing.
67	Iron and Steel.
71	Machinery, other than Electric.
72	Electrical Machinery, Apparatus and Appliances.
732	Road Motor Vehicles.
86	Professional, Scientific and Controlling Instruments, Photographic and Optical Goods, Watches and Clocks.

One of the largest Japanese export industries missing in the above is SITC 735 (Ships and Boats). I collected the data for this groups, but out of 15 observations 8 countries had zero imports of ships and boats from Japan. Since my model is in the log-linear form, we had to exclude those 8 samples with zero values from calculations, which reduced the number of observations to 7. Seven observations with four variables model is inadequate. Due strictly to this statistical problem I ignored the ships and boats industry in the present study. Foodstuff and toy industries are also ignored here for the same reason. To include those industries we have to increase the number of observations to cover Asian

and other under-developed countries.

The number of sample countries used was 15.[1] They are European, North American and Pacific advanced countries. New Zealand is excluded from computation due to the difficulty of getting the tariff data, and it is suspected that in New Zealand quotas rather than tariffs may have greater impact on its volume and pattern of imports. The under-developed countries are exluded due also to the difficulty of getting the tariff data.

The value of imports (in thousands of U.S. dollars) for each commodity groups by jth country from Japan in 1965 (Jan. to Dec.) were taken from Commodity Trade Statistics (New York: United Nations, 1966). Only the data for U.S.A., Canada and Australia are reported on f.o.b. bases, and the rest are on c.i.f., bases. This raises some difficulty for the present estimation.[2] The per capita import values were

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[1] Italy, Austria, Portugal, Netherland, United Kingdom, France, Germany, Belgium and Luxemburg, Norway, Australia, Denmark, Switzerland, Canada, Sweden, United States, (in the order from the lowest to the highest per capita income).

[2] Bela Balassa, in his Trade Prospects for Developing Countries (Homewood, Illinois: Richard D. Irwin, Inc., 1964), Appendix Table A1.2.2., calculated the freight and insurance as a percentage of c.i.f. for each of 50 non-processed or crudely processed products. But he took all manufactured goods as one bundle and calculated one percentage figure for it. The conversion of c.i.f. to f.o.b. values of imports of each manufactured commodity groups was not done here due to the lack of enough data at hand and to the limitation of time assigned for this thesis.

obtained by dividing them by the population of the jth country.

The population data (in thousands) were taken from Demographic Yearbook, 1965, (New York: United Nations, 1966), Table 4; Estimates of Midyear Population.

The nautical distances between Japan and 15 countries (in nautical miles*) were estimated from Philips Record Atlas (London: George Philips and Son Limited, 1965), 26th edition, page 1.

The per capita income data (in U.S. dollars) were taken from Yearbook of National Accounts Statistics 1966 (New York: United Nations, 1966), Table 7A.

The tariff data except for Australia were taken from Atlantic Tariff and Trade by Political and Economic Planning (London: George Allen and Unwin Ltd., 1962), which calculated the unweighted arithmetic average[1] of the tariff rates of various countries on the basis of the 1959 data. Various specific duties were converted into ad valorem equivalents in the document. It ignores Dillon round changes.[2] Up to

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* 1 nautical mile = 1,852.27 meters or 1.15 land miles.

[1] For the discussion of various method of weighting, see: Bela Balassa, "Tariff Protection in Industrial Countries An Evaluation", Journal of Political Economy, Vol. LXXIII (December, 1965), pp. 573-594.

[2] But it is not too serious as these changes were 20 percent of existing tariffs (or less) and only on a limited number of commodities.

date, this volume is the only document that brings together on a comparable basis the tariff rates of the major European and North American countries. There are no such documents for under-developed countries.

One main reason for the lack of such detailed comparisons has been the absence of any common tariff classification. The main trading countries of Western Europe have all adopted the Brussels Tariff Nomenclature, which has introduced a considerable measure of uniformity into European tariff nomenclature. Within each of the 1100 main headings, however, no common system of subheadings has yet been adopted. The United States and Canada do not use the BTN. Each has its own system of classification.

Hence, to use the 1959 structure as a proxi for the 1965 trans-Atlantic tariff structure is the best I could do. It is problematic to do so, but within the limited amount of time assigned for this thesis it is not possible to go into the census data of each country for the 1965 tariff rates and to convert them into some comparable standard.

How far the 1959 tariff structure reflects the 1965 structure is an open question. For EEC countries the common external tariff was not established in 1959 yet. The external tariff was to be established in three stages.[1] In the first

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[1] Confer: N.V. Sovani, The European Economic Community (Poona, India: J.S.S. Institute of Economic Research, 1965), p. 7.

stage the difference between the common tariff and the existing national tariff was to be reduced by 30 percent on January 1962. In the second stage a similar reduction of 30 percent was to be achieved in 1966. And in the third stage the full remaining adjustment was to be made. The final adjustment was completed in June 1968 while this thesis was being prepared. Countries other than EEC members have apparently gone through various adjustments of their tariff rates in the 1960's. Thus the results should be interpreted with some reservations from this respect.

The Canadian rates shown in Atlantic Tariff and Trade are the British Preferential and the Most-Favoured-Nation rates. The rates used in my study are the latter ones, since they are extended over to Japanese products.

Where the rate has some range the mid-point was taken and used in my calculations.

As for Australia, I used the data from Bulletin International des Douanes 1966-67 No. 166 (Brussels: International Customs Tariff Bureau, 1967), which follows the Brussels Tariff Nomenclature (BTN). I converted my SITC industry classifications into BTN numbers by Standard International Trade Classification Revised, Statistical Papers Series M, No. 34 (New York: United Nations, 1961) to consult the Australian tariff document.

The method of estimation of parameters in the models is the simple least squares method.

Where a country had zero imports from Japan, this country was excluded from calculation, which reduced the number of observations in the case. To limit the theoretical estimation of parameters to the non zero observations is the most justifiable method in the logarithmic regression equation.

The results of my calculations are given in Table 4 and Table 5. Implications of the results for the coefficient for per capita income difference variable (b_1) will be discussed first. Then, the results for transportation costs and tariffs will be examined. My results will be compared with those of Tinbergen, Pöyhönen and Linnemann in the course of the discussion. As a by-product of this research into the relevance of Linder's hypothesis, a strong possibility of Japan's low-wage exports to advnaced countries in the context of the product-cycle theory of innovation and trade will be mentioned.

Let us now look at the values of b_1 in the tables. Consider the aggregate model first (Table 4). The coefficient b_1 turned out to be positive in sign and highly significant. The magnitude of the coefficient is slightly greater than unity; i.e., per capita imports of a country from Japan increases slightly more than proportionately as per capita income difference between the two increases.[1]

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[1] Note that although Japan is a highly industrialized country, her per capita income level ranks lowest among other advanced countries included in this study in the year 1965.

TABLE 4

RESULTS FOR THE AGGREGATE MODEL

$$\log X_j/N_j = b_o + b_1 \log |y_j - y| + b_2 \log G_j$$

$$(-) \qquad (-)$$

	b_o	b_1	b_2	b_3	R^2*	Year	No. of Countries	No. of Observations
	-0.22536	1.05906	-0.53296		0.5061	1965	14	14
		(2.90178)	(-0.79118)		(0.4163)			

Method of estimation: Simple Least Squares

Data were based on imports statistics

t-values are shown in parenthesis under each coefficient

$X_j = \sum_i X_{ij}$ = jth country's total imports from Japan

N_j = population size of jth country

y_j = per capita income level of jth country

y = per capita income level of Japan

G_j = geographical distance between Japan and jth country

b_o = intercept

* In the parenthesis is adjusted R^2 ($\bar{R}^2$). $\bar{R}^2 = 1 - \frac{n-1}{n-k}(1 - R^2)$, where n = number of observations, K=3 (number of variables).

TABLE 5

RESULTS FOR THE DISAGGREGATED MODEL

$$\log X_{ij}/N_j = b_0 + b_1 \log |y_j - y| + b_2 \log G_j + b_3 \log T_{ij}$$

$$(-) \qquad (-) \qquad (-)$$

SITC	b_o	b_1	b_2	b_3	R^2*	Year	No. of Countries	No. of Observations
5 Chemicals	-3.2681	0.5512 (1.3500)	0.3497 (0.4220)	-0.2069 (-0.3696)	0.2304 (-0.0048)	1965	14	14
65 & 84 Textiles	6.5534	0.7950 (1.6618)	-1.9339 (-2.1436)	-1.1344 (-1.7138)	0.5882 (0.4759)	1965	15	15
67 Iron & Steel	9.1499	0.7815 (0.9321)	-3.1213 (-2.5314)	0.2769 (0.5533)	0.6806 (0.5742)	1965	13	13
71 Machinery other than Electric	1.5721	0.3820 (0.7717)	-0.7591 (-0.8647)	-0.2055 (-0.3411)	0.2180 (0.0048)	1965	15	15

* In the parenthesis is the adjusted R^2 ($\bar{R}^2$). $\bar{R}^2 = 1 - \frac{n-1}{n-k}(1 - R^2)$, where n = number of observations, K=4 (number of variables).

TABLE 5--Continued

SITC	b_o	b_1	b_2	b_3	R^2	Year	No. of Countries	No. of Observations
72 Electric Machinery	2.9853	1.2762 (3.5150)	-1.6632 (-2.3180)	-0.5751 (-1.2373)	0.7911 (0.7342)	1965	15	15
732 Road Motor Vehicle	0.7322	1.3915 (1.6667)	-1.4804 (-1.4357)	0.1991 (0.1762)	0.5329 (0.3772)	1965	13	13
86 Professional Equipments	1.3159	0.7904 (2.0968)	-0.9027 (-1.2992)	-0.5619 (=1.5688)	0.6762 (0.5375)	1965	11	11

TABLE 5--Continued

Critical t values:

Levels of Significance \ No. of Observations	11	13	14	15
10%	1.415	1.383	1.372	1.363
5%	1.895	1.833	1.812	1.796
2.5%	2.365	2.262	2.228	2.201

Method of estimation: Simple Least Squares

Data were based on imports statistics

t-values are shown in parenthesis under each coefficient

$X_j = \sum_i X_{ij}$ = jth country's total imports from Japan

X_{ij} = jth country's imports of ith commodity from Japan

N_j = population size of jth country

y_j = per capita income level of jth country

y = per capita income level of Japan

G_j = geographical distance between Japan and jth country

T_{ij} = nominal tariff rate (%) on imports of ith commodity by j

b_o = intercept

The model is disaggregated by commodity groups. Table 5 gives their estimation results. The most distinct feature of the table is the positive sign of b_1 in all calculations, which supports the result arrived at in the aggregate model. The coefficient is highly significant in electric machinery and professional equipment industries. It is significant at 10 percent level in textile and road motor vehicle industries. The magnitude of the coefficient is larger than unity in both electric machinery and road motor vehicle industires.

All of these results reject Linder's hypothesis. Per capita income difference does not appear to be important in the way as was suggested by Linder. Linder's theory suggested that the closer the per capita income levels between two countries, the greater the per capita imports of a country from another. My calculations have given the opposite results; the greater the per capita income difference between two countries, the larger the per capita imports of a country from another.

The effect of per capita income levels upon aggregate trade flows between individual countries was ignored by Tinbergen, Pöyhönen and Linnemann. Will my results shed any light upon whether or not their assumption is justifiable? My results indicate that, for trade in manufactured goods among advanced countries, the difference of per capita income levels between the trading countries is important, although in

the opposite way of what can be expected from Linder's theory, in affecting the per capita imports of a country from another. Thus, the per capita income levels of the exporting and importing countries are not two indpendent variables, but the difference between them is important as a single variable in determining trade in manufactured goods among industrial countries. Hence, it does not seem to be justifiable to ignore altogether the effect of per capita income levels upon trade flows. The economic interpretation of how the difference of per capita income levels affects the per capita imports of a country from another will be discussed later on.

Next, implications of my results for transportation costs are to be examined. The coefficient for the distance variable (b_2) for the aggregate model is of expected sign but not significant, and its value is rather small (-0.53). This suggests that the transportation cost is not so much an important factor affecting Japan's aggregate export intensities with industrial countries abroad. Tinbergen and Linnemann arrived at a significant distance variable. But, their calculations included under-developed countries, and the value of the coefficient for the distance variable was higher where the percentage of under-developed countries in the total sample countries was higher.[1] Pöyhönen's calculation

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[1] See Table 1 and Table 3. In Tinbergen, 16.7 and 50 percent of the total sample countries were under-developed countries in calculations A and C respectively. In Linnemann, calculations AC-7 and AC-31 were based on non-zero trade flow observations, and calculation AC-23 was adjusted to include more zero flows.

which included no under-developed countries arrived at a very small value of the coefficient (-0.00157). It cannot be statistically verified here whether under-developed country's imports from advanced country, or its exports to advanced country, or trade among under-developed countries are most sensitive to the transportation costs. However, from the results of Tinbergen, Pöyhönen and Linnemann, it is suspected that the inclusion of a number of under-developed countries in my calculations may increase the value of the coefficient for distance variable and may cause it to be significant.

Table 5 gives the results for the disaggregated model. The coefficient b_2 is significant and its value is over 1.5 in textile, iron and steel, and electric machinery industries. The iron and steel industry appears to be most sensitive to transportation costs. The coefficient takes the value of -1.4804 in the road motor vehicle industry and is significant at 10 percent level. The coefficient is of expected sign in all industries except in chemical industry, for which the fit of the regression was very poor.

The results for the coefficient for nominal tariff rates (b_3) is generally quite poor. Table 5 shows that b_3 is significant at 10 percent level only in textile and in professional equipment industries. The coefficient is of positive sign in iron and steel and in road motor vehicle industries, but not significant in both cases. This poor result is understandable due to the limitation of the data used, and suggests that the use of 1959 data as a proxy for

1965 tariff structure is not to be justified well.

Lastly, can we attach any economic meaning to the fact that the coefficient for per capita income difference turned out to be positive in all calculations and statistically significant in some? Would it imply a low-wage trade by any means? A full-fledged investigation of this point would have to be done in some other research, but, from the initial impressions of the figures for b_1 in Tables 4 and 5, the author feels that the low-wage trade in the product-cycle theory of innovation and trade[1] provides a most plausible explanation.

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[1] See Chapter 1, pp. 16-19.

Recent studies have shown that wages reflect human capital,[1] and in the United States increased recognition has been given to the human capital component of foreign trade.[2] These suggest that an industry with higher wage level

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[1] The average human capital invested in each worker in an industry means the amount of education and training possessed by the average worker in the industry. Attempts have been made in the recent literature to use manufacturing-value-added information in estimating factor intensities of production. Victor R. Fucks, in Changes in the Location of Manufacturing in the United States since 1929 (New Haven: Yale University Press, 1962), pp. 164-67, considers as labour-intensive industries those with the ratio of wages to manufacturing value added greater than the average for all manufacturing. In GATT publication, International Trade 1964 (Geneva: September, 1962), U.S. manufacturing industries are categorized into three groups according to the level of wages per head and non-wage-share of manufacturing value added per head. More recently, Bruce W. Wilkinson, in Canada's International Trade: an Analysis of Recent Trends and Patterns, op. cit., Chapter 5, uses wages per employee and the non-wage-share of manufacturing value added per employee as indicators of the human-capital and physical-capital intensity of production respectively to look into factor intensities of manufactures in Canada. Hal. B. Lary, in his Imports of Manufactures from Less Developed Countries, National Bureau of Economic Research, (New York: Columbia University Press, 1968), employs the same technique. In Chapter 2, Lary confirms the results of Waehrer's dissertation work, op. cit., on wage structure.

[2] See particularly Peter B. Kenen, "Nature, Capital and Trade", Journal of Political Economy (October, 1965), pp. 437-60; Peter B. Kenen and Elinor B. Yudin, "Skills, Human Capital, and U.S. Foreign Trade: Variations on a Theme by Leontief", International Economics Workshop, Columbia University, (December, 1965); also the two articles by Donald B. Keesing, "Labour Skills and International Trade: Evaluating Many Flows with a Single Measuring Device", Review of Economics and Statistics (August, 1965), pp. 287-94, and "Labour Skills and Comparative Advantage", American Economic Review: Papers and Proceedings (May, 1966), pp. 249-58.

is a more competitive export industry since higher wage reflects higher human capital. The higher human capital represents the better ability to innovate and invent things on the part of the technological leaders, and the better ability to catch up with the technological frontier on the part of the imitators.

We may roughly assume that wages are generally higher in the higher per capita income country. This assumption does not seem to be too far away from reality since the education and skill levels of the labour force and the qualities of capital equipments are usually higer in the higher per capita income country. Japan is a highly industrialized country, and yet her per capita income level ranks lowest among advanced countries included in this study. Thus, if the product cycle of innovation and trade is the dominating force for trade in manufactures, Japan is expected to be the country which can claim low-wage exports better than any of the other advanced countries with higher per capita income levels. The positive and highly significant coefficient b_1 in the aggregate model is consistent with this expectation.

The product-cycle theory distinguishes three product stages: (1) new, (2) maturing, and (3) standardized. Of particular significance is the point that the different factors of production--skilled and unskilled labour, managerial ability, and physical capital--are of varying relative importance

in these phases.[1]

The values of b_1 are relatively high for the electric machinery industry (1.2762) and for the road motor vehicle industry (1.3915). The fit of the regression is reasonably good in each of them. These figures indicate that the low-wage trade in the product-cycle theory may well be most relevant for these industries of Japan. Generally, both industries have entered the stage of standardization years ago in higher income countries.

Textile products have long reached the standardized stage in Japan as well as in other advanced countries. The industry is probably the most labour intensive industry among the seven included in my study. The technology is stable, the production runs are long, human capital needs have diminished, and semi-skilled or comparatively unskilled labour has become a larger portion of the work force. Thus the cost of low-wage labour is expected to matter most in this industry. But its value of b_1 is not so high (0.7950) relatively speaking. This can be explained by the rapid growth of textile production in under-developed countries such as India, Hong Kong, Pakistan, Phillippines, Korea, and Taiwan. Thus Japan finds it harder to claim low-wage trade in the industry due to the rapid emergence of lower wage

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[1] For a good summary of the characteristics of the phases of the product cycle, see: Wilkinson, Canada's International Trade, op. cit., pp. 116-120.

competitors from under-developed areas of the world.

Similarly, some of the under-developed countries have started producing watches, clocks, cameras, lighters, etc. Thus, Japan's professional equipment exports have also gradually been suffering from their competition. This explains the value of b_1 being not so high (0.7904).

The iron and steel industry may well have reached the standardized stage of the product cycle in Japan. Its technology is stable and the production runs are long. It is even possible that Japan has higher technology in this industry than many of the higher income countries. Since the industry is a relatively highly physical-capital-intensive industry, it is not surprising that the value of b_1 for the industry (0.7815) was lower than those for more labour-intensive industries. But a careful investigation of the characteristic of the industry's production would have to be done before anything can be said from my figure.

The fits of the regression for chemical and machinery other than electric industries were very poor, so nothing can be revealed from figures for these industries.

We have seen that Tinbergen took into account the effect of commodity concentration of exports and Linnemann the effect of the goodness of fit of commodity composition of supply of exports with that of demand for imports upon aggregate trade flows between individual countries. But, neither Tinbergen nor Linnemann explained what determined

the commodity composition of supply of exports or demand for imports. Linder's theory suggested that a country's commodity compositions of supply of exports and demand for imports of manufactured products would be determined by its demand structure, which was mainly dependent upon its per capita income level. Thus, according to his theory, the goodness of fit of commodity composition of supply of exports with that of demand for imports of manufactured goods would be determined by the similarity of per capita income levels of the trading countries.

However, my statistical experiments for 1965 Japanese exports of manufactured products to industrial countries resulted in the rejection of Linder's hypothesis. It was further indicated that my regression results might well imply Japan's low-wage export trade with advanced countries in the product cycle of innovation and trade. If the product-cycle theory is the most relevant explanation of trade in manufactures, a country's commodity compositions of supply of exports and demand for imports of manufactured goods would depend upon its relative technological positions and wage levels of domestic industries compared with those of outside countries.

The next chapter highlights the tentative conclusions reached, and suggests some areas of future research.

4.1 Appendix to Chapter IV

The deviations of actual from theoretical values of the per capita imports of various countries, and the deviation as a percentage of actual value are given in the following tables. As was mentioned at the end of the third chapter, the effect of the economies of scale was ignored in my models due to the data difficulty. It is possible that they may exert significant systematic influence upon per capita imports of various countries from Japan. Japan seems to be a country which can achieve economies of scale in the domestic market. If the economies of scale are better achieved in Japan than in her trading partner, the theoretically predicted value of imports of the product by the country from Japan will be underestimated in my regression model. In this case, the deviation of actual from theoretical value is expected to be positive.

TABLE 6

DEVIATIONS OF ACTUAL FROM THEORETICAL VALUES (ANTI-LOG OF DEPENDENT VARIABLE IN THE REGRESSION) OF PER CAPITA IMPORTS (IN CURRENT U.S. DOLLARS)

	Total	5 Chemicals	65 & 84 Textiles	67 Iron & Steel
Italy	0.041317	0.029009	-0.063422	
Austria	-1.0460	-0.11207	0.32093	-0.06793
Portugal			-0.014163	
Netherland	6.0476	0.19354	0.19095	0.13286
U.K.	-0.85504	-0.00014198	-0.013933	-0.038883
France	-3.5989	-0.1399	-0.16386	-0.047669
Germany	-0.67354	0.58138	-0.24432	-0.029873
Bel. & Lux.	-0.53994	-0.14407	-0.16619	0.39498

TABLE 6--Continued

	71 Machinery other than Electric	72 Electric Machinery	732 Road Motor Vehicles	86 Professional Equipment
Italy	0.11995	-0.096327	-0.0066191	-0.018967
Austria	-0.081783	0.025731		
Portugal	-0.14405	-0.04720		
Netherland	0.14291	0.29683	0.036418	0.12486
U.K.	-0.034998	0.018388	0.0075681	0.15248
France	-0.083752	-0.056075	-0.081711	-0.073448
Germany	1.0545	-0.056653	0.12789	-0.10899
Bel. & Lux.	0.013383	0.021446	-0.084825	0.0053573

TABLE 6--Continued

	Total	5 Chemicals	65 & 84 Textiles	67 Iron & Steel
Norway	15.679	-0.080808	0.56924	0.29529
Australia	19.059	1.2856	5.9122	3.6908
Denmark	1.5819	-0.19654	1.5305	-0.056347
Switzerland	1.2145	0.69004	-0.69867	-0.015908
Canada	-3.2708	-0.1123	-2.0135	-1.8869
Sweden	-0.89291	-0.22456	0.65456	0.17356
U.S.A.	-12.671	-0.15191	-1.3841	-2.3336

TABLE 6--Continued

	71 Machinery other than Electric	72 Electric Machinery	732 Road Motor Vehicles	86 Professional Equipment
Norway	-0.12596	0.14381	0.15672	
Australia	1.4918	1.0924	3.1292	0.4664
Denmark	0.12012	-0.20734	0.3699	
Switzerland	-0.15974	0.5761	-0.14797	-0.12056
Canada	-0.15082	-0.75259	-0.094683	-0.12624
Sweden	-0.023601	0.10195	-0.096607	0.4019
U.S.A.	-0.24699	-1.3191	-0.98943	-0.33049

TABLE 7

PERCENTAGE DEVIATIONS OF ACTUAL VALUES FROM THEORETICAL VALUES (ANTI-LOG OF DEPENDENT VARIABLE) OF PER CAPITA IMPORTS

$$\frac{\text{ACTUAL VALUE - EXPECTED VALUE}}{\text{ACTUAL VALUE}} \times 100\ (\%)$$

SITC	Total Exports	5	65 & 84	67	71	72	732	86
Italy	4.07	19.53	-85.47		-55.68	46.94	-65.53	-45.92
Austria	-122.71	-167.77	57.15	-160.40	29.92	-86.54		
Portugal			-43.57		-144.40	-378.07		
Netherland	62.53	39.07	34.68	57.86	63.15	36.42	31.50	41.18
U.K.	-22.76	-4.63	-5.26	-45.31	11.60	-18.60	6.54	52.81
France	-359.71	-73.55	-171.04	-135.04	-71.07	-70.02	-527.17	-107.07
Germany	-17.80	58.55	-216.79	-191.49	-35.43	81.43	63.66	-92.21
Bel. & Lux.	-10.66	-62.72	-47.66	73.66	6.68	4.43	-146.50	2.10

TABLE 7--Continued

SITC / Total Exports	5	65 & 84	67	71	72	732	86
Norway	73.98	-27.76	57.47	77.32	37.95	-92.89	55.10	
Australia	69.11	81.52	87.49	76.34	72.08	-50.73	88.72	59.16
Denmark	17.07	-57.70	65.80	-241.83	-82.31	26.94	69.54	
Switzerland	11.69	59.15	-78.93	-6.50	38.56	-69.39	-120.40	-16.47
Canada	-29.90	-53.12	-206.30	-106.52	-83.75	-29.99	-11.98	-25.51
Sweden	-11.35	-69.84	42.39	55.29	17.60	-8.07	-80.37	41.79
U.S.A.	-99.44	-64.48	-74.82	-92.63	-81.38	-50.73	-144.78	-82.23

CHAPTER V

CONCLUDING REMARKS

This study has been concerned with testing the relevance of Linder's hypothesis: the more similar the demand structures of two countries, the more intensive is the trade between countries. The similarity of per capita income levels was used as an index of similarity of demand structures between countries, and the level of per capita imports of a country from another was used as an index of intesnity of trade between the two in my models. The statistical test was applied to the data of per capita imports of 15 advanced countries from Japan in 1965. Calculations were made for aggregate of all Japanese export commodities and for each of the classified commodity groups. My models and results were compared with those of Tinbergen, Pöyhönen and Linnemann, all of whom were concerned with the determinants of total trade flows between individual countries. A summary of the tentative conclusions reached in this study will be given below, then the area of study which deserves further empirical research will be mentioned.

5.1 A Summary Statement

1. The results in Chapter IV rejected Linder's hypothesis. It was shown that the greater the per capita income difference between two countries, the larger the per capita imports of a country from another. This statement was statistically correct at a certain probability confidence level only for 1965 Japanese exports of selected manufactured products to highly advanced countries, whose per capita income levels were all higher than Japanese level. Hence, my results indicate that the similarity of demand structures of countries is not the dominating force in determining the intensity of trade in manufactures between industrial countries.
2. The above statement gives rise to a question: what, then, is the dominating force determining the intensity of trade in manufactures? It was suggested that low-wage exports as a stage of product-cycle of innovations and trade was a plausible explanation to the fact that the effect of per capita income difference was not unimportant but was important in the opposite way of what could be expected from Linder's theory. If the product-cycle theory is the relevant explanation of trade in manufactures, a country's commodity compositions of supply of exports

and demand for imports would depend upon its relative technological positions and wage levels of domestic productions compared with those of countries abroad.

3. The effect of per capita income levels upon aggregate trade flows between individual countries was assumed away by Tinbergen, Pöyhönen and Linnemann. My results indicated that the per capita income levels of the exporting and importing country might not necessarily be important as independent variables, but that the difference between them was influential of the per capita trade in manufactures between the two countries. (As was stated in the above section, the implication of this statistical result was the product cycle theory.) Therefore, their rather bold assumption about the negligible effect of per capita income levels is hard to be justified for trade in manufactures, at least among industrial countries.

4. The coefficient for transportation costs was not significant in the calculation for the aggregate model. The results of Tinbergen, Pöyhönen and Linnemann indicates that the inclusion of under-developed countries in the sample raises the value of the coefficient quite substantially. If so, the inclusion of a number of under-developed

countries in my calculation may increase the magnitude of the coefficient for distance variable and may make it significant. Since what had happened in the examples of the works reviewed could not be precisely identified, this point cannot be made strongly. The results for the disaggregated model showed that the coefficient was statistically significant and its value was large (overl .5) in textile, iron and steel, and electric machinery industries. It was fairly significant (at 10 percent level) and substantial in the road motor vehicle industry. On the whole, the distance of transportation seems to reflect transportation costs reasonably well.

5. The results for the coefficient for nominal tariff rate in my calculations were generally poor. This can be attributed to the limitation that the 1959 tariff structure (except for Australia) was used as a proxy for 1965 structure. The coefficient was significant only at 10 percent level in textile and professional equipment industries. From these rather passive results, we may say that the 1965 tariff structure for manufactures is substantially different from the 1959 structure.

5.2 Area for Further Empirical Works

1. A more comprehensive test of Linder's hypothesis would be interesting. My work tested it only in terms of Japanese exports to advanced countries. By increasing the number of observations by taking reciprocal trade among advanced countries, it will be possible to reach a more general conclusion about the relevance of Linder's hypothesis to the trade in manufactured goods among industrial countries.
2. It seems that the low-wage export in the product cycle theory is quite relevant for Japanese exports to the more advanced countries. This point should be investigated in detail for each of the Japanese export industries before any general conclusion about the relevance of the low-wage trade for over-all Japanese exports can be drawn.
3. The product-cycle theory of trade seems to be a very promising theory. Specifically, the relevance of the theory for Japanese exports not only to advanced but also to under-developed countries deserves much greater empirical attention. Japan seems to be a good example for testing the full theory against, since my results implied that Japan was low-wage trading to advanced countries, and it

is very likely that Japan is technological-gap exporting to the under-developed countries.

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